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Utilization of the Seven Ishikawa Tools (Old Tools) in the Six Sigma Strategy

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Abstract

The Statistical process control (SPC) has become one of the most important applications of statistics in the industry. It covers a variety of tools, and it can be consider that the Seven Ishikawa ("old") tools (the name is also Seven quality control tools) are among the most useful and famous tools. The main goal of the use of these tools in the manufacturing processes is to determine if a process being analyzed is within the established parameters (In control process) or not (Out of control process). The typical property of the statistically controlled process (In control process) is that values of an investigated parameter of the production are between regulating limits. Through the time, a constant improvement has been accepted as the main objective of companies for all the fields, but this improvement is always keeping SPC and its Seven Ishikawa tools as the base. One of the latest strategies utilized is a Six sigma strategy, which works having as the base the Quality statistical tools and techniques combined with a well-focused management. The development of the Six sigma strategy follows certain general steps established by Motorola that are analyzed with a general point of view and its relationship with the SPC.

1. INTRODUCTION

It is a fact that all the productions methods and processes are subjected to variability. The variations that occurs into the processes are classified into two groups, first we have the variations due to inherent causes or common causes, this are unavoidable causes of variability inherent to the nature of the process. These causes produce a distribution of values which is approximately normal and which is predictable. The other group of variations is due to special causes; these are caused by special changes into the process or environment. For instance, one of the components fails, not properly, material is used, the adjustment of the equipment is incorrect, etc.

The Six sigma strategy and the Seven Ishikawa tools (since a long time ago) have proven success for many companies and their use is increasing day by day with the constant needs of excellency for all the products and services. This document shows in a practical and graphical way how the Seven Ishikawa tools are involved into the Six sigma strategy. It has been found that these tools create a very good basis, which id newly joined with different types of managerial tools for complex quality strategy of companies.

2. Six Sigma Strategy

Six sigma strategy was developed by Motorola in the early 1990s.It has had a big success on famous companies like General Electric, Texas Instrument, IBM, Polaroid and many others. The goals of this strategy are:

- 3.4 Defects per million by reducing variability and meeting customer expectations (approach to zero defects)
- breakthroughs for every area of operation
- warrants a vision for a long-term period.

Launch the company in the World class Sigma is well known like the standard deviation from the mean, its function is to measure the variability of processes. The sigma value indicates how often defects are likely to occur, so the higher the sigma value, the lower the likelihood of defects. (*For instance: 6 sigma means 3.4 defects per million or 99.99966 % non defective, 5

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sigma means 233 defects per million or 99.9769% non defectives and so on - see **Fig.1**). Six sigma uses Defects per Opportunities (DPOs) as a measurement tool. The meaning of defect refers to anything that results in customer dissatisfaction. In general, the organizations operate with a 3-4 sigma quality level.

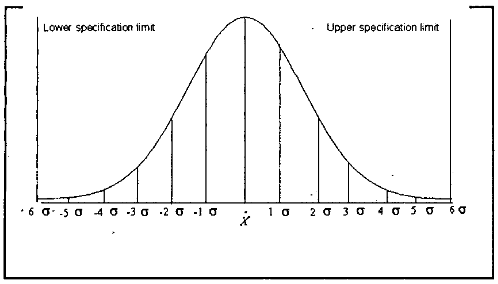

Fig. 1 Graphical meaning of Six Sigma

The strategy of Motorola used a set of useful steps, which can be followed as guidance for all the companies wanting to get a Six Sigma level. This steps are known as DMAIC (Define, Measure, Analyze, Improve, and Control).

2.1 DMAIC (Define, Measure, Analyze, Improve and Control)

Define: Definition of the goals of the improvement activity. At the highest level, operations level, and project level.

Measure: Measure the existing system. It is necessary to establish adequate metrics so the Progress (according to the goals) will be monitored.

Analyze: Analyze the system using statistical tools

Improve: The big change will be the improvement of the system finding new ways to do the things, to get better results.

Control: It is necessary to control the new system to be sure that it has been implanted and that it will continue.

Motorola has used for the application of the Six sigma strategy a structured flowchart which guide them to obtain the wanted results. The flowchart is based on the DMAIC procedure (see **Fig. 2**).

In addition, It is suggested for the process of implementation to apply the 14 Deming's points, because Six sigma refers to a global change, in few words, to a new culture.

Another very important issue for the implementation of Six Sigma is the Leadership, and the human resource involved that leads the company to get the expected results. Six Sigma must be implemented from the top-down, it means there should be a commitment from the CEO until the lowest levels. There should be a special training for the people involved, they are known with the names of Black Belts, Master Black Belts, Green Belts, Champions and Sponsors. These people will be developing projects that will report the continuing improvement; their cooperation and productivity will be decisive for the success of the program. The cost of implementation of this program can be seen as very expensive and nonsense for many companies but the rewards of a well implementation are much higher that the inversion.

3. SEVEN QUALITY TOOLS (ISHIKAWA QUALITY TOOLS)

Kaoru Ishikawa integrated the 7 Statistical tools in the 1960's. He promoted these tools; their main purpose is to improve all kind of processes, promoting the interrelation and teamwork of all people involved. The tools are easy to use, so it would let everybody to understand, learn to manage them and to take advantage of the improvements that these represent.

The main goals of the quality tools are:

- increase the communication between operators and management
- detection of Problems and decrease the recurrence of problems
- improve all kind of processes including manufacturing, educational, and business processes.

Cause and Effect Diagram: This tool is also well known as Ishikawa Diagram (see **Fig. 3**) or fishbone diagram. This diagram analyzes potential causes of a defect, error or problem of a process under identification. There are 4 major categories or causes, which influence the quality characteristics being studying: Man, Machine, Method and Material, called also the 4M's of the manufacturing process. Besides of the main categories, sub categories will emerge also, which will guide to the team to discover the real causes of the effect.

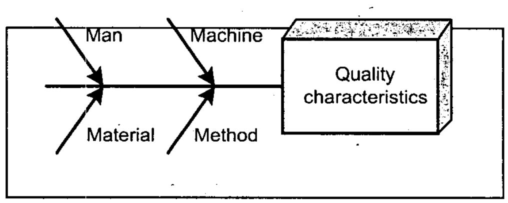

Fig. 3 Cause and effect diagram

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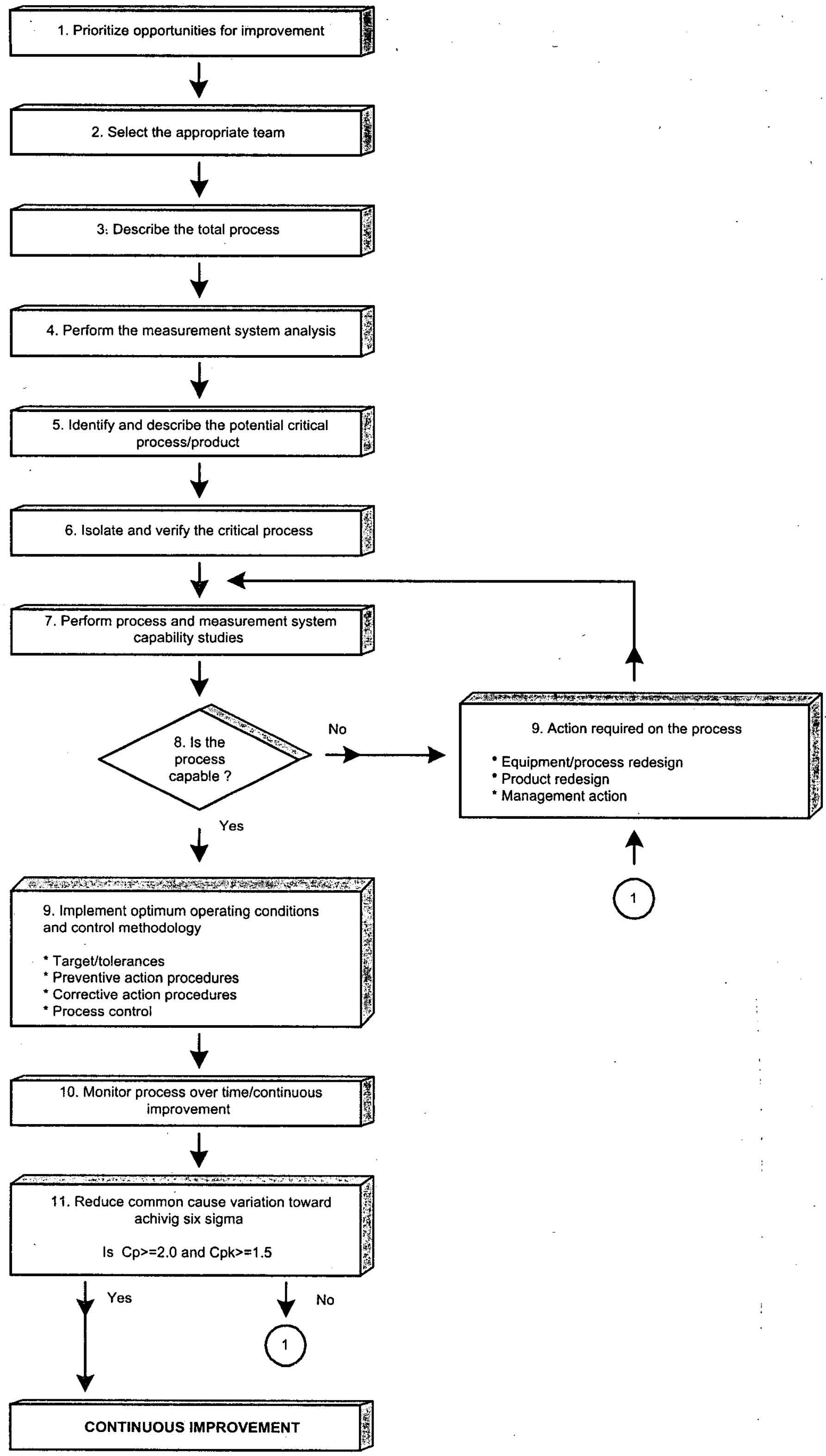

Fig. 2 Product/process improvement flow diagram (according to the Motorola inc.)

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Run Chart: This tool permits the study of observed data for trends or patterns over time (see **Fig. 4**), the y-axis corresponds to the variable being measured, and the x-axis corresponds to the time. It can be use for comparisons of a variable measurement before and after the process has been modified.

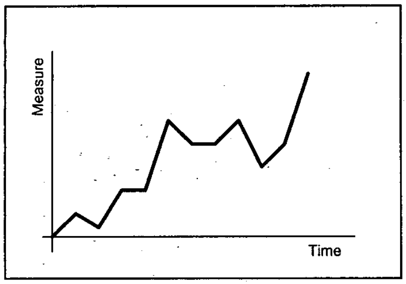

Fig. 4 Run chart

Scatter Diagram: For this diagram is necessary to have data of two variables in pairs, one dependent and the other one independent, and they will be plot on the x-axis and y-axis respectively **(Fig. 5)**. The diagram is useful to show the strength of the relationship between two variables, e.g. linear, quadratic, etc.

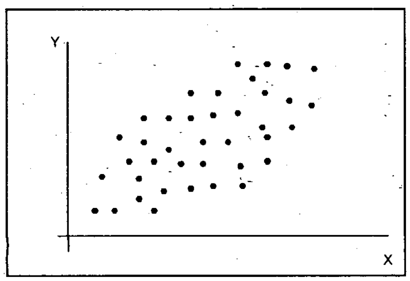

Fig. 5 Scatter diagram

Flow chart: It is a graphical representation of all the necessary and sequential steps to perform a process or activity, contains standard figures each of them with a special meaning (**Fig. 6**).

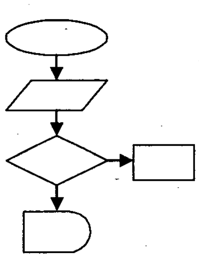

Fig. 6 Flow chart

Pareto Diagram: The principle of this diagram (sees **Fig. 7)** is "The vital few and the little many". A few of the manufacturing process characteristics cause most of the quality problems on the line considering that most process characteristics account for very little of the quality problems on the manufacturing line.

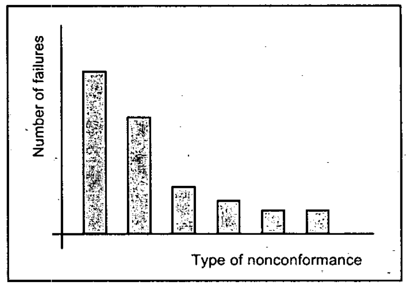

Fig. 7 Pareto diagram

Histogram: It is a graphical representation of the data by magnitude; the observed frequency is represented by a rectangle, which has a height that symbolizes the frequency of each interval or cell (**Fig. 8**)

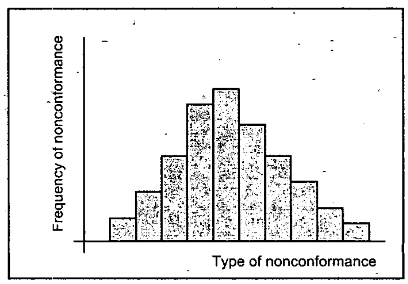

Fig. 8 Histogram

Control Charts: The control charts are used to distinguish graphically between the two sources of variability specially in manufacturing processes (common and special causes). This chart contains a UCL (upper control limit) and a LCL (lower control limit) and by means of them can be identified the type of variation in the process.

4. OPTIMIZATION OF THE ISHIKAVA TOOLS UTILIZATION FOR DIFFERENT TYPES OF PRODUCTION

There are different types of production in electronic industry. Some specialized components and equipment are manufactured in a very low numbers of products, some components and equipment are produced in bigger volumes (series manufacture) and

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some are manufactured in very high volumes (mass production). Efficiency of the use of different types of quality tools differs in dependence on the type of production.

It has been found that the use of the histogram, Pareto diagram, control chart and scatter diagram for optimization of the production of low volume meets with the problem of low number of measured data. On the other hand the use of cause and effect diagram, run chart and flow chart can significantly contribute to the quality improvement of the production.

Series and mass production of electronic components and equipment make acquisition of sufficient volume of data possible. Therefore the use of all Ishikawa tools can be based on sufficient number of measured values. Especially for mass production the scatter diagrams are very significant, because the use of them can substantially decrease the expenses joined with a measuring equipment for the acquisition of data.

Very significant condition of using of the Ishikawa tools is normality of data. Therefore it is necessary to test the normality before the application of the tools. There have been developed different methods (e.g. Box-Cox transformation, exponential transformation etc.) for transformation of non-Gaussian data into the Gaussian ones.

The use of Ishikawa tools has gives information about the quality of production. Application of control charts shows what time the quality has been too low (the time, when the control chart is out of the band limited by UCL and LCL). However, it is possible to meet with a following case: the control chart does not cross boundaries of the control band limited by the UCL and LCL, however the quality of the production (e.g. tolerances of the products) is unsatisfactory. This information is a very significant for manufacturer, because it means that the production equipment (e.g. production line) is well controlled but its properties are not sufficient for requested accuracy. Therefore it is necessary to realize such the production on the equipment (production line) of higher quality.

5. Conclusions

- There is an important relation between the Seven Ishikawa tools and the Six sigma strategy. Six sigma strategy requires tools that enables visualize, analyze, and make conclusions about processes, problems, and activities in general. The Seven Ishikawa tools contribute to that purpose, they are important elements that belong to the SPC (Statistical Process Control) which is an essential part for the implementation of the Six sigma strategy.
- Although Six sigma strategy is a new strategy it is based in old statistical and management tools and theories that have been used for many years. The strategy apply those methods in a structured and systematical way; giving extremely importance to the human resources that should be trained and educated for the radical changes that this strategy implies. The application of the strategy with not enough knowledge of statisctis or awareness of the process involved can lead to the failure of all the implementation.
- The Seven Ishikawa Tools can be applied in several steps of the flow chart of the Six sigma strategy; for instance the Pareto analysis is very useful in step No.1 "The prioritization of opportunities for improvement". In step No.3 "The description of total process" the flow-charts, Pareto analysis, and the cause and effect diagram are useful. In step No.4 "Perform measurement system analysis" the scatter diagram can be very useful. In Step No.6 "Isolate and verify the critical process" the cause and effect diagram is again useful. All types of the Control Charts can be used in Step 7 "Perform process and measurement system capability studies". In steps 8 and 9 all SPC Charts can be useful, in general.

The use of different methods of production quality improvement is typical for contemporary electronic production. The level of technological processes, e.g. for manufacturing of VLSI integrated circuits, is very high and it is not possible to realized such the production without application of some tools for the production quality control. Six sigma strategy and Statistical Process Control (= Seven Ishikawa Tools) are two of many different methods of this highly significant area.

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